REDUCING READMISSIONS IN DIABETIC PATIENTS

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EXECUTIVE SUMMARY

This project investigates the underlying factors contributing to hospital readmissions among diabetic patients using a large, real-world healthcare dataset. Through advanced data exploration with SQL, I identified key diagnostic patterns and filtered patient conditions specifically related to diabetes.

Machine learning techniques, including Logistic Regression and Random Forest, were applied to predict which patients were at high risk of being readmitted within 30 days. The analysis revealed that:

- A significant number of patients were missing critical lab tests such as A1C and Max Glucose Serum, which are essential for proper diabetes monitoring.
- The type of medical specialty assigned played a major role in readmission rates, suggesting potential mismatches in patient care pathways.
- Medication management, especially insulin use and certain drug combinations, emerged as strong predictors of readmission risk. Patients prescribed multiple medications or experiencing dose changes were particularly vulnerable.
- To communicate these findings, I built a Tableau dashboard and used Python visualizations, enabling clear and actionable insights for both clinical and non-technical stakeholders. These results provide a foundation for improving discharge planning, medication review, and care coordination, ultimately reducing costly readmissions.

OBJECTIVES

- To identify key factors contributing to 30-day hospital readmissions in diabetic patients.
- To analyze whether medical specialties, missing test results, or unknown diagnoses are significant contributors to readmission.
- To evaluate the role of medication combinations and insulin usage in predicting readmission risk.
- To apply machine learning models (e.g., Logistic Regression, Random Forest) to predict high-risk patients.
- To communicate findings effectively using Python visualizations and Tableau dashboards.
- To provide actionable recommendations that support healthcare providers in reducing preventable readmissions.

PROBLEM STATEMENT & HYPOTHESES

Problem Statement:

- Why are diabetic patients being readmitted within 30 days, and are these readmissions influenced by missing tests, improper specialty assignment, or other medical factors?

Hypotheses:

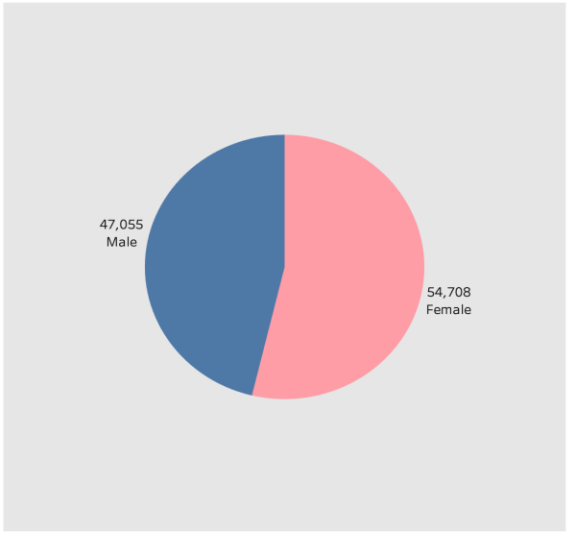
- Patients assigned to the “Unknown” medical specialty are more likely to be readmitted within 30 days.
- Patients who were not tested for A1C or max glucose serum are more likely to be readmitted.
- Patients treated by general practitioners have a higher readmission rate than those by endocrinologist.
- Lack of documentation or testing may contribute to increased patient readmission risk.

Methodology

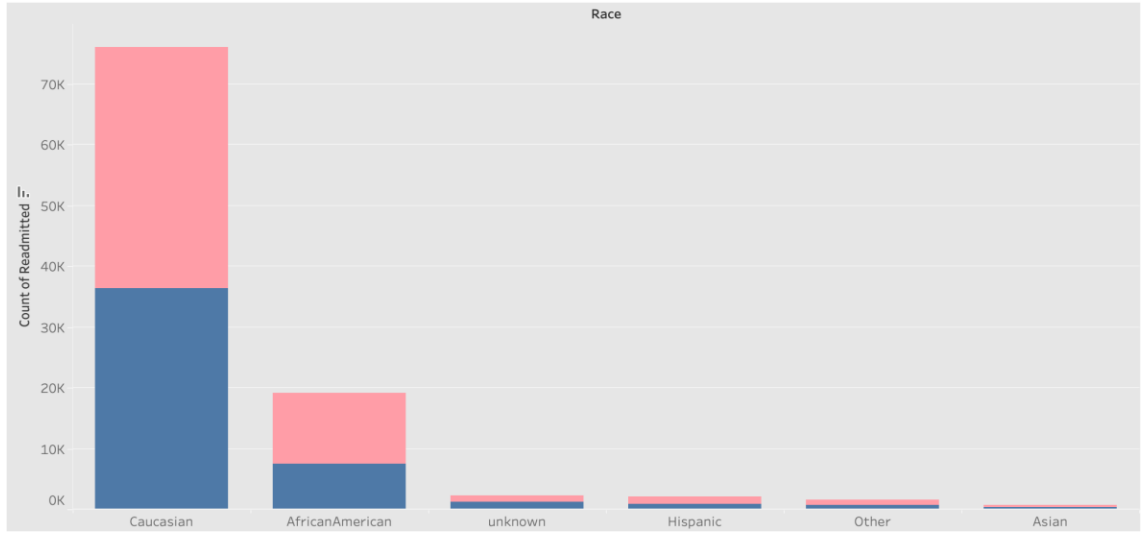
- Data Preparation & Cleaning
  - Used PostgreSQL and Python (NumPy, Pandas) to clean and preprocess the dataset.
  - Handled missing values, removed duplicates, standardized medical specialty categories, and filtered irrelevant records.
- Feature Engineering
  - Created key features: Readmission flags (<30, >30, No), diagnostic categories from diag_1–3.
- Exploratory Data Analysis (EDA)
  - Explored relationships between race, A1C, glucose, length of stay, age, number of medications, diagnosis codes, and medical specialty.
- Diagnosis Classification
  - Grouped ICD-9 codes into categories (e.g., diabetes, rehab, joint replacement) for clearer insights.
- Modeling
  - Trained and evaluated Logistic Regression, Random Forest, and XGBoost models.
  - Measured performance using accuracy, precision, recall, F1-score, and confusion matrix.
- Insights & Visualization
  - Built interactive Tableau dashboards to visualize trends and findings.

Patient Readmission Dashboard Overview

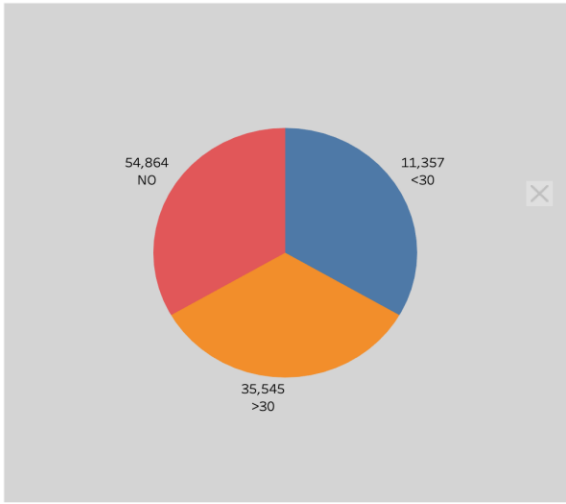
Gender Count for Readmission Patients



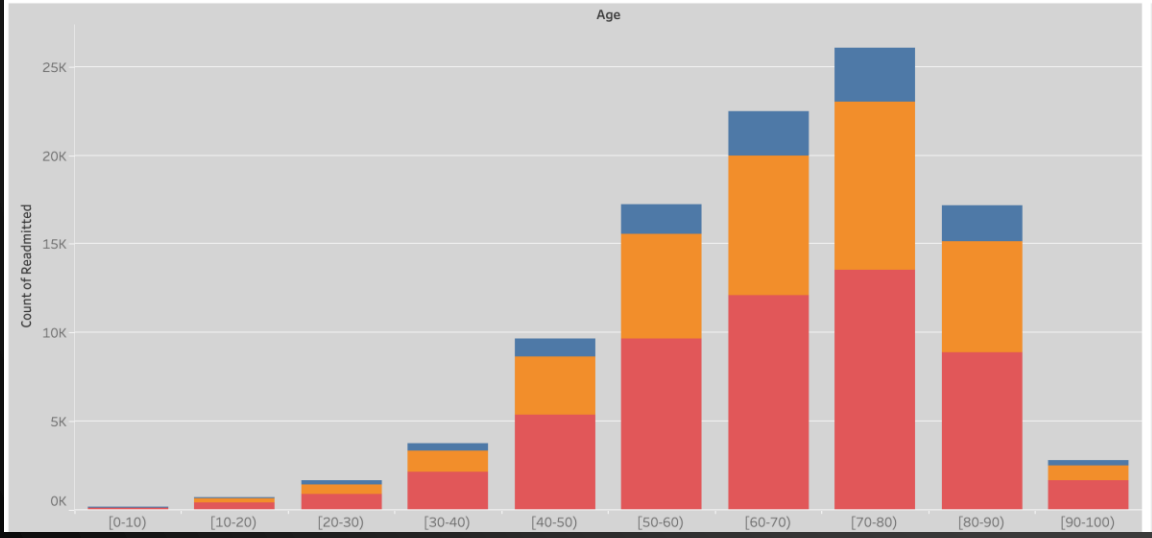
Race Count of Readmission



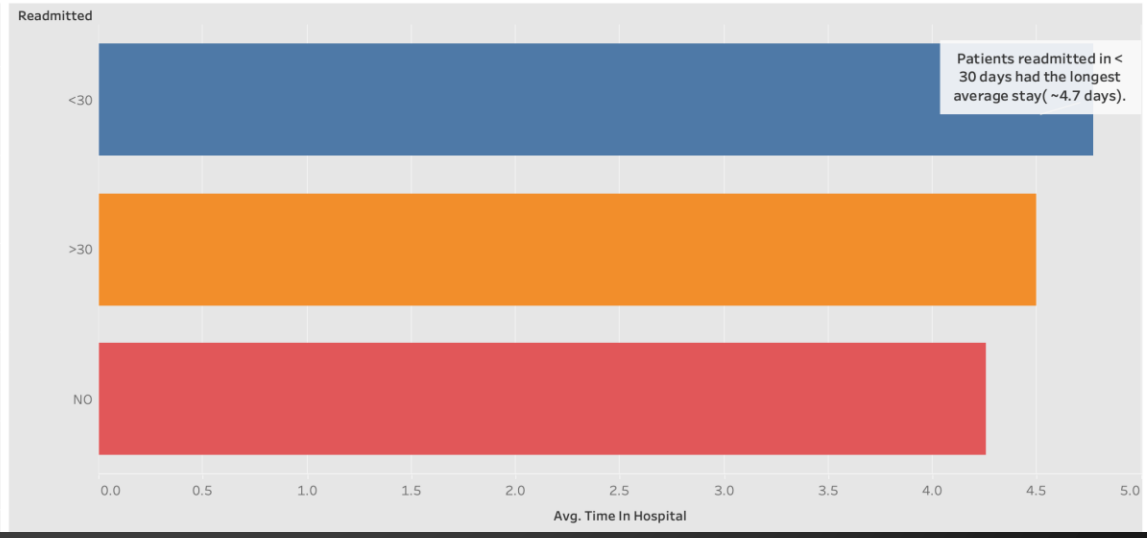
Readmission Overview Breakdown: No Readmission vs. <30 vs. >30 days



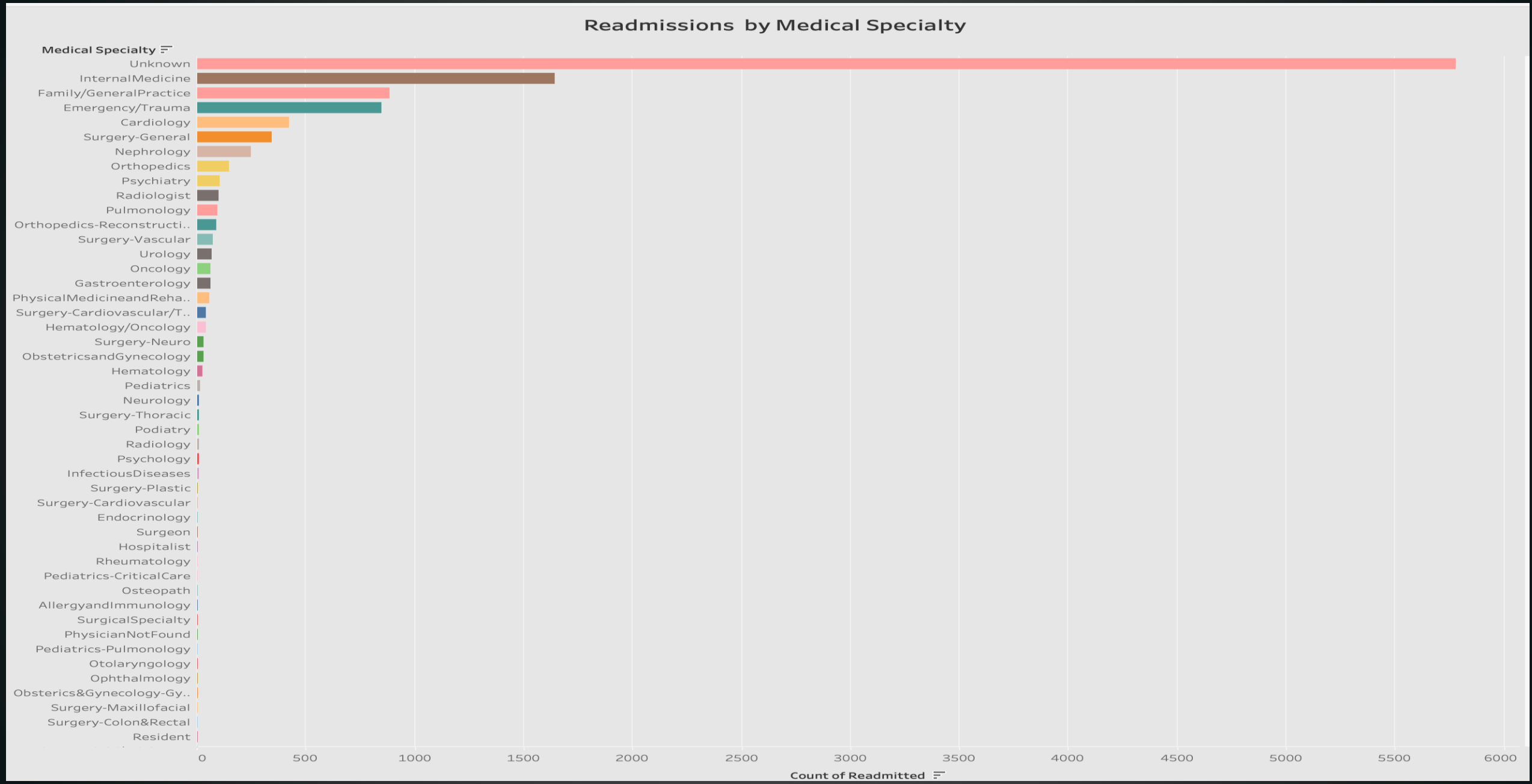
Age Grouped by Readmission



Patients Avg Time in Hospital



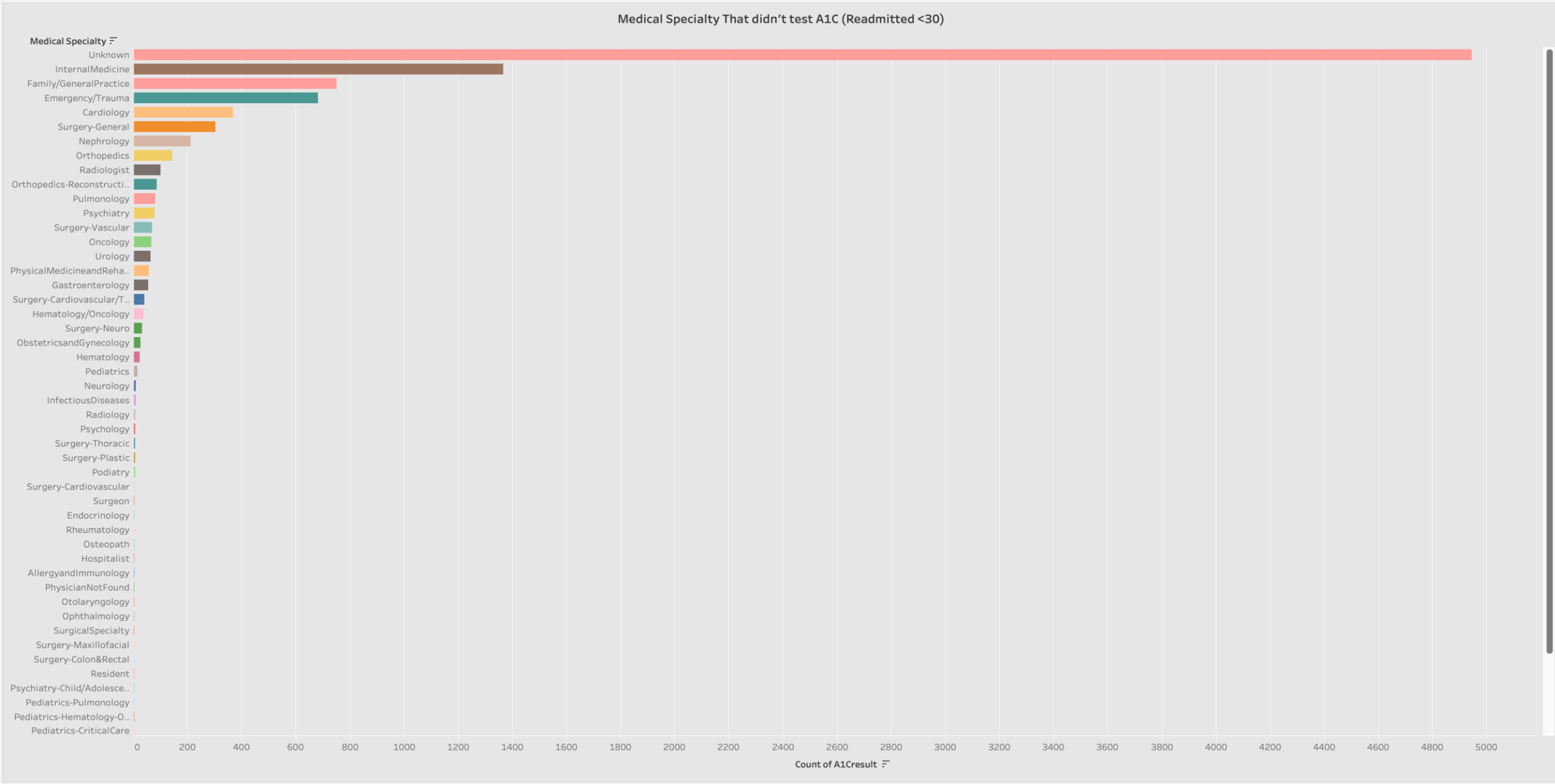
SPECIALTY ANALYSIS


Readmissions by Medical Specialty
Medical Specialty
Unknown
InternalMedicine
Family/GeneralPractice
Emergency/Trauma
Cardiology
Surgery-General
Nephrology
Orthopedics
Psychiatry
Radiologist
Pulmonology
Orthopedics-Reconstructi..
Surgery-Vascular
Urology
Oncology
Gastroenterology
PhysicalMedicineandReha..
Surgery-Cardiovascular/T..
Hematology/Oncology
Surgery-Neuro
ObstetricsandGynecology
Hematology
Pediatrics
Neurology
Surgery-Thoracic
Podiatry
Radiology
Psychology
InfectiousDiseases
Surgery-Plastic
Surgery-Cardiovascular
Endocrinology
Surgeon
Hospitalist
Rheumatology
Pediatrics-CriticalCare
Osteopath
AllergyandImmunology
SurgicalSpecialty
PhysicianNotFound
Pediatrics-Pulmonology
Otolaryngology
Ophthalmology
Obsterics&Gynecology-Gy..
Surgery-Maxillofacial
Surgery-Colon&Rectal
Resident
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
Count of Readmitted

READMISSION BY SPECIALTY ANALYSIS FINDINGS

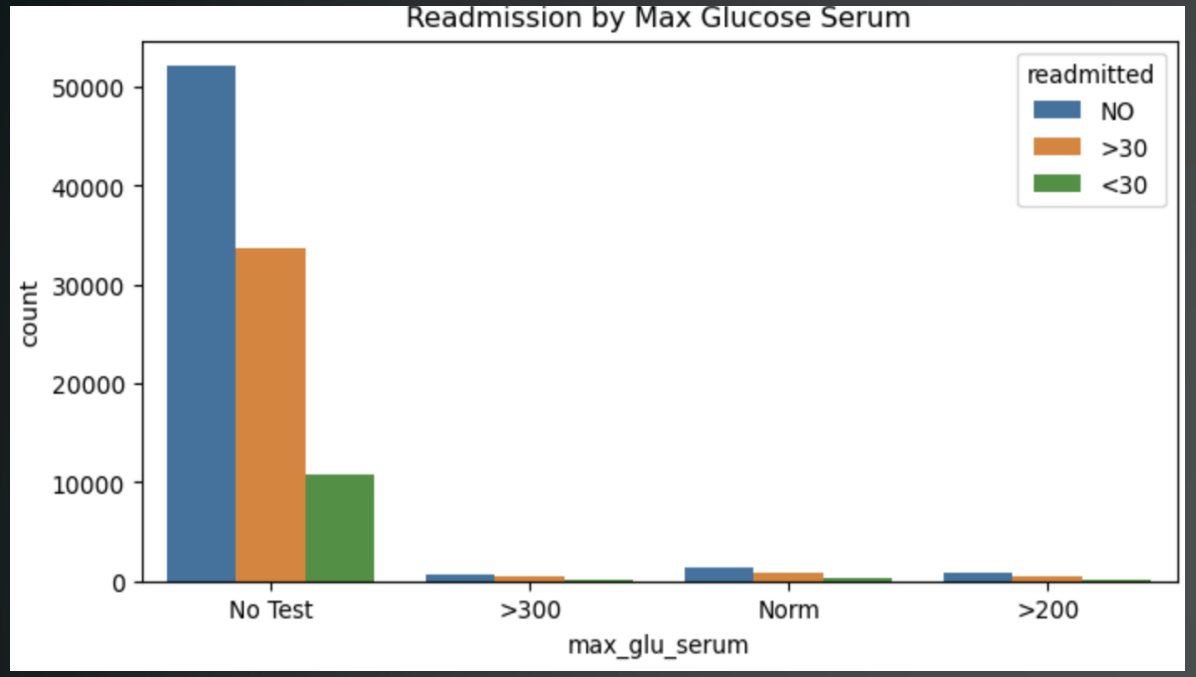
- A significant portion of readmitted patients (over 50%) are documented under the ‘Unknown’ medical specialty category. This lack of accurate provider attribution limits the ability to identify accountable care teams and may contribute to missed diagnostic and follow-up opportunities. Improving documentation of specialty care can enhance targeted interventions and accountability in patient outcomes.

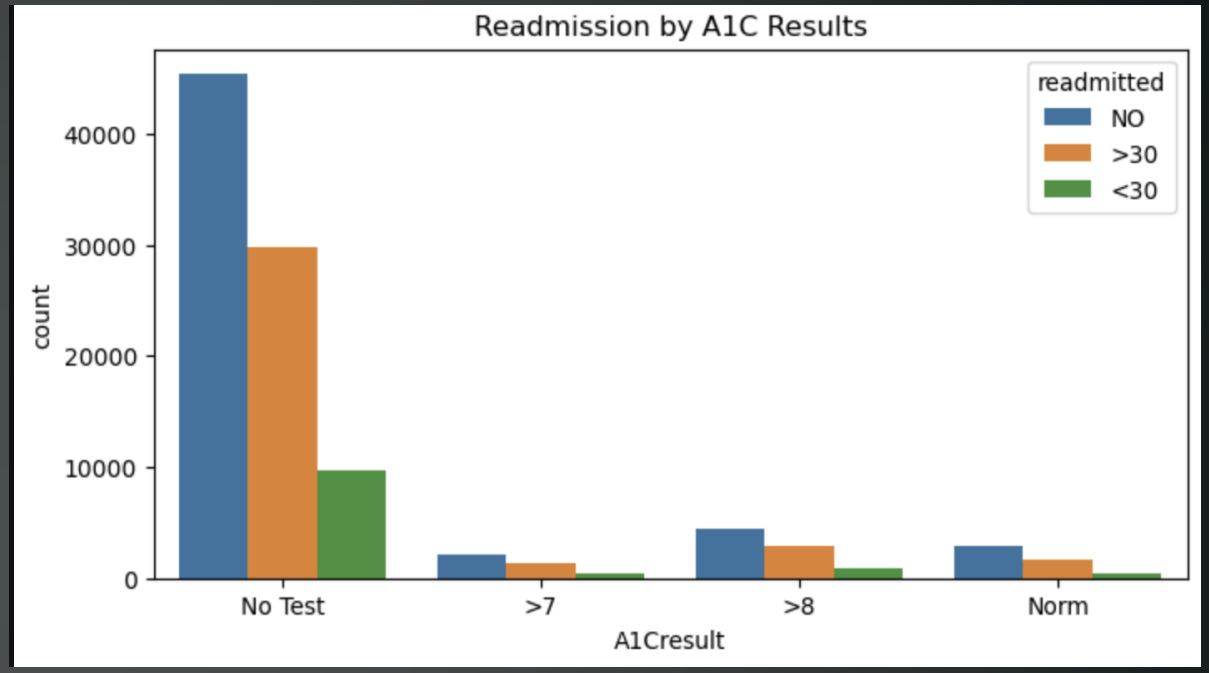
- Patients treated by general practitioners exhibited a higher number of readmissions compared to those treated by endocrinologists, suggesting that specialized care may play a role in reducing the likelihood of readmission.


Medical Specialty That didn't test A1C (Readmitted <30)
Medical Specialty
Unknown
InternalMedicine
Family/GeneralPractice
Emergency/Trauma
Cardiology
Surgery-General
Nephrology
Orthopedics
Radiologist
Orthopedics-Reconstructi..
Pulmonology
Psychiatry
Surgery-Vascular
Oncology
Urology
PhysicalMedicineandReha..
Gastroenterology
Surgery-Cardiovascular/T..
Hematology/Oncology
Surgery-Neuro
ObstetricsandGynecology
Hematology
Pediatrics
Neurology
InfectiousDiseases
Radiology
Psychology
Surgery-Thoracic
Surgery-Plastic
Podiatry
Surgery-Cardiovascular
Surgeon
Endocrinology
Rheumatology
Osteopath
Hospitalist
AllergyandImmunology
PhysicianNotFound
Otolaryngology
Ophthalmology
SurgicalSpecialty
Surgery-Maxillofacial
Surgery-Colon&Rectal
Resident
Psychiatry-Child/Adolesce..
Pediatrics-Pulmonology
Pediatrics-Hematology-O..
Pediatrics-CriticalCare
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
4200
4400
4600
4800
5000
Count of A1Cresult

SPECIALTY ANALYSIS

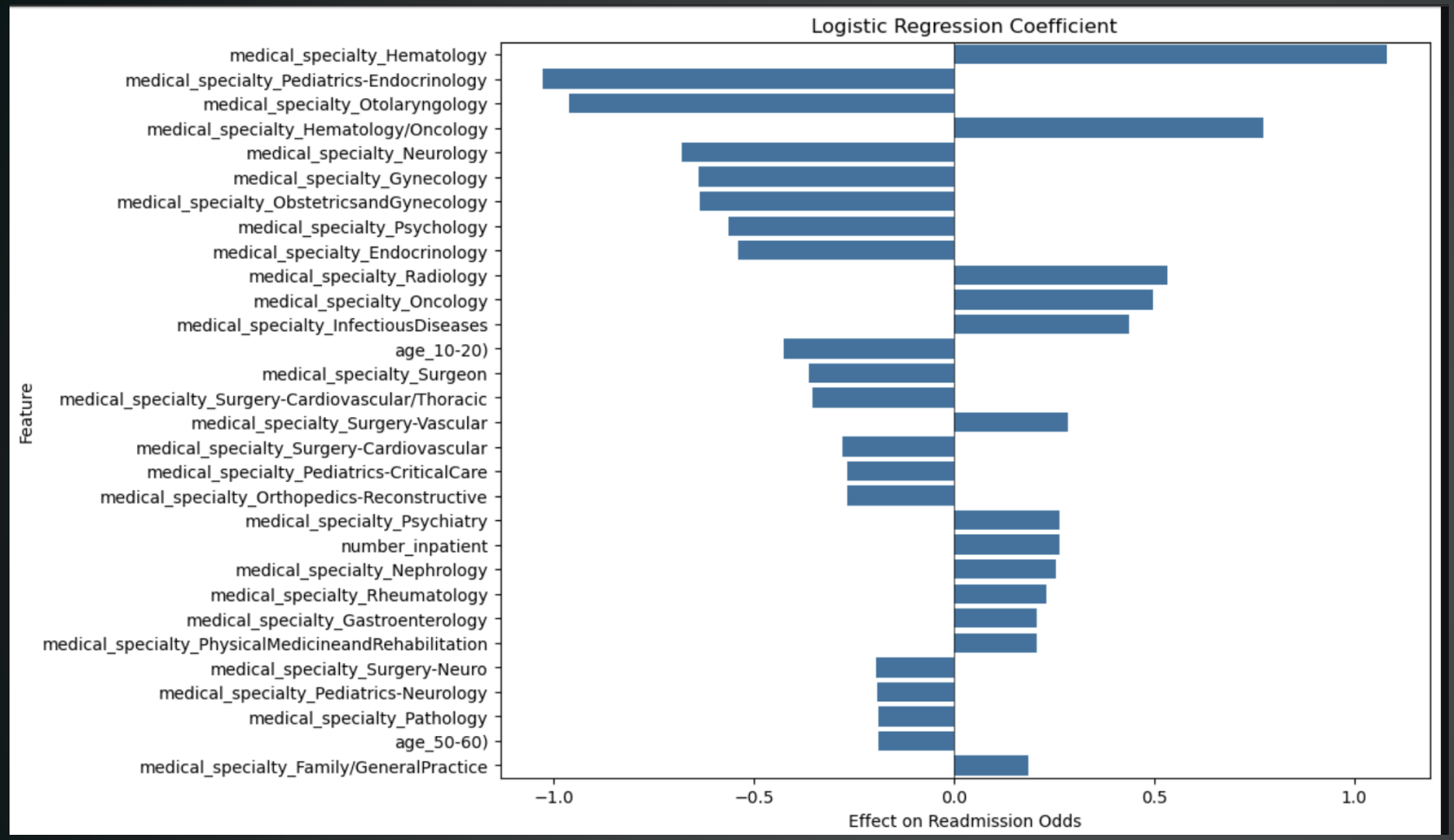
A substantial number of readmitted patients did not have A1C levels tested during their stay, highlighting a potential missed opportunity for monitoring a key diabetes marker. This gap could impact the timely management of glycemic control and contribute to preventable readmission. Notably, many of these cases were associated with an ‘Unknown’ medical specialty, raising concerns about gaps in accountability or documentation during care transitions.





GLUCOSE & A1C ANALYSIS

LOGISTIC REGRESSION FINDINGS



Logistic Regression Findings

- Hematology, Hematology/Oncology, and Endocrinology patients show the highest odds of readmission.
- Pediatrics-Endocrinology, Neurology, and Gynecology patients have a lower risk of readmission.
- Age (10–20, 50–60) is linked to a slightly lower readmission risk.
- Overall, the model confirmed that lack of testing and lack of specialty alignment increases readmission risk.

MEDICATION COMBINATION ANALYSIS

GLUCOSE & A1C ANALYSIS- FINDINGS & IMPLICATIONS

Findings

Lack of Testing Is Common

A substantial number of patients who were readmitted—both <30 and >30 days—had no glucose or A1C test results recorded during their visit.

Readmissions Still Occur Despite Normal or Controlled Readings

Some readmissions occurred even when glucose or A1C results were in the normal or moderate ranges, suggesting that testing alone doesn't guarantee reduced risk—follow-up care and treatment plans may also be lacking.

Limited Use of Critical Diagnostic Tools

The low frequency of glucose values >300 and A1C values >8 suggests that only a small portion of high-risk patients are being properly identified or tested.

Implications

- Implement Mandatory Testing Protocols

Require baseline A1C and glucose serum testing for diabetic or high-risk patients during admission to better stratify risk and personalize treatment.

- Improve Care Coordination and Follow-Up

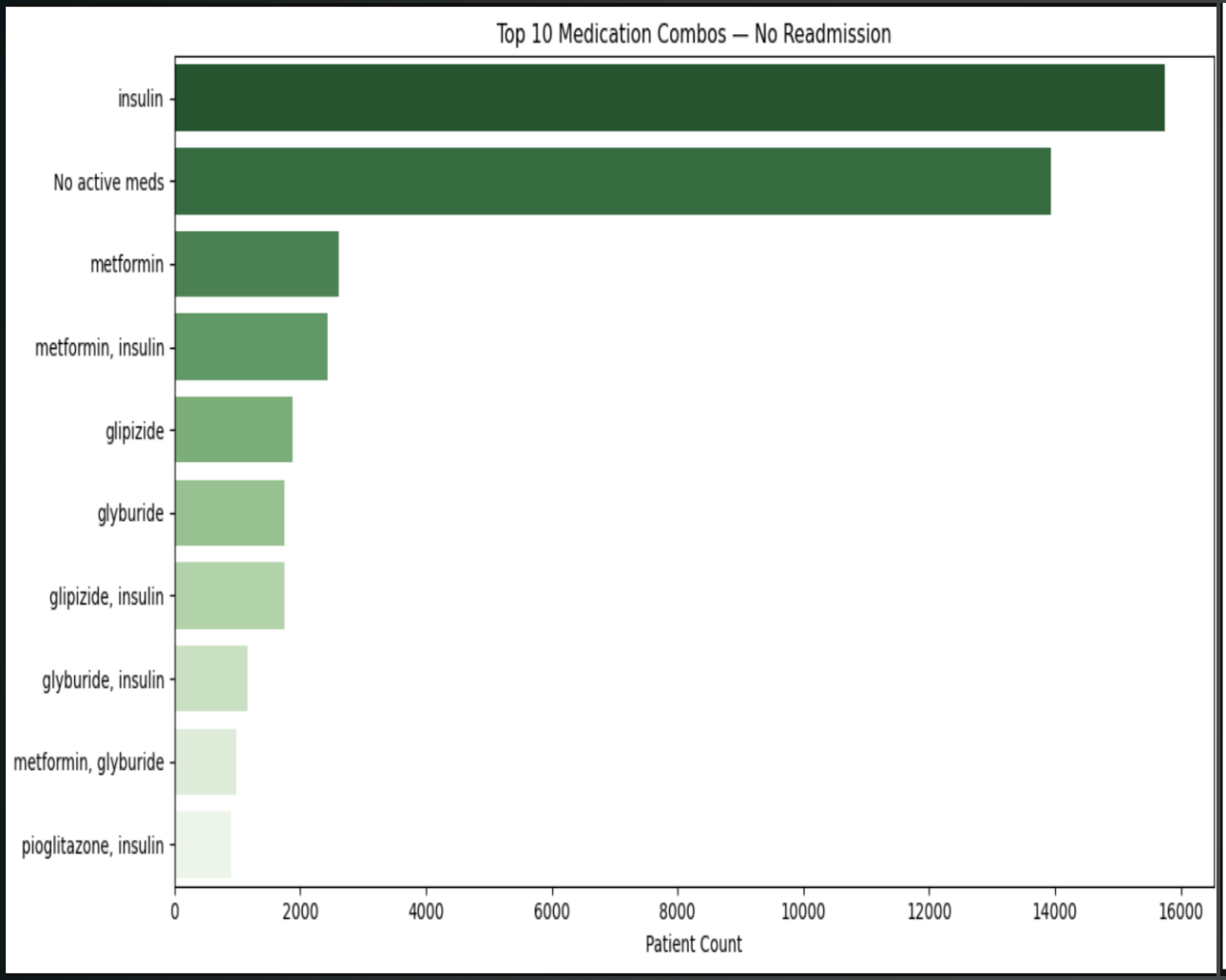
Even patients with "normal" results were readmitted, indicating a need to enhance discharge planning, education, and outpatient care.

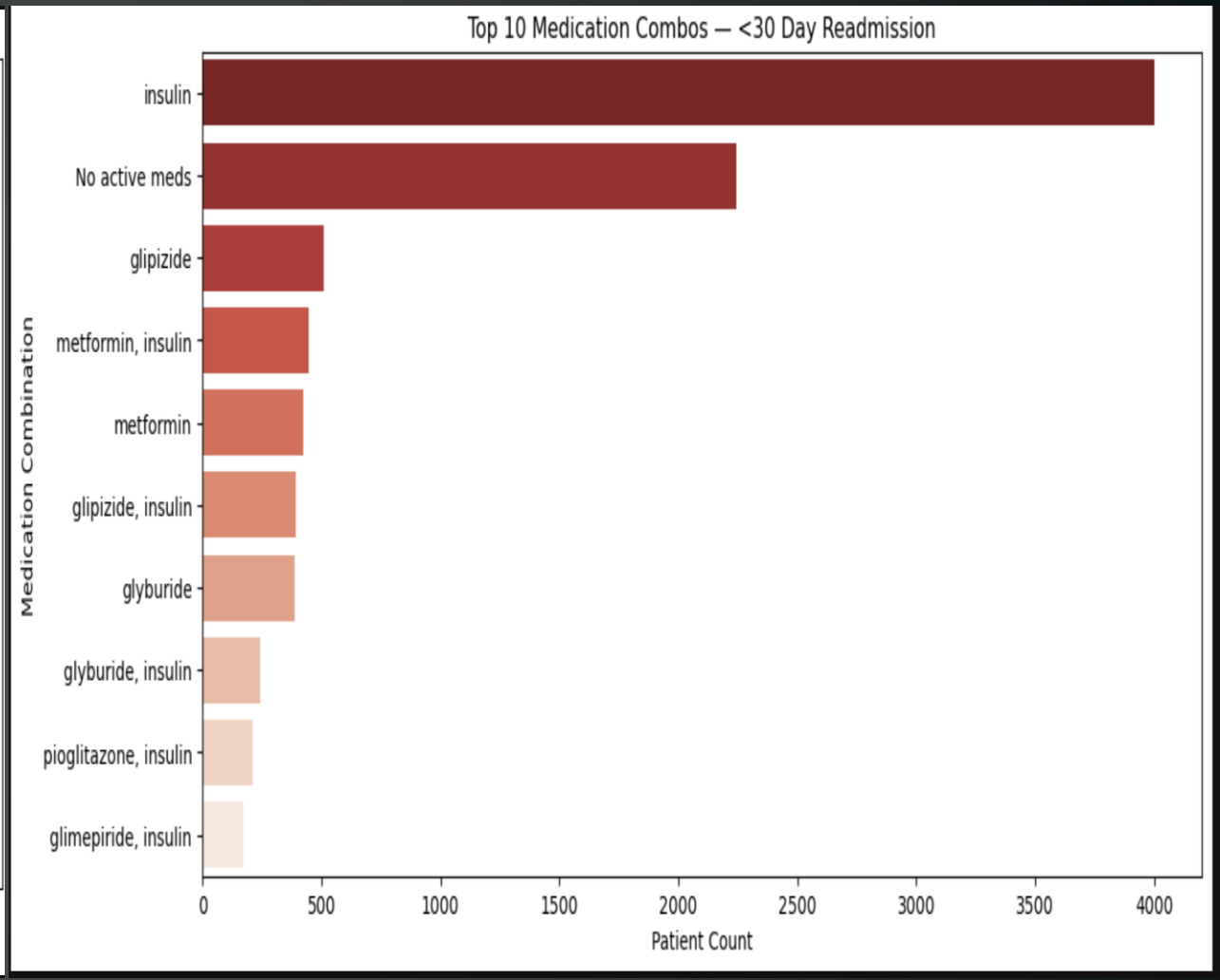
- Data-Driven Intervention Triggers

Introduce automated alerts in the EHR to flag missing glucose/A1C data before discharge or to trigger an endocrinology consult when values are abnormal.

- Training and Accountability for Providers

Educate medical staff—especially those in general practice—on the importance of glucose and A1C testing for diabetic patient management to reduce avoidable readmissions.





TOP 10 MEDICATION COMBOS COMPARISON

FINDINGS AND IMPLICATIONS FOR THE COMPARISONS

Findings

- **Insulin is the top player: It's the most used treatment in both groups, but it doesn't seem to cause many readmissions. About 80% of insulin-only patients stay out of the hospital—better than average.**

- **No meds at all is common too: Many patients aren't on active treatments, and most (around 83%) avoid readmission. But for those who do return, it might be because their diabetes isn't managed well.**

- **Some combos raise red flags: Treatments with drugs like glipizide, glyburide, or glimepiride (especially mixed with insulin) show up more in the readmission group. For example:**

- **Glipizide alone: Roughly 35% readmission rate—higher than average.**

- **These meds can cause low blood sugar (hypoglycemia), which often leads to emergency visits.**

- **Safer options stand out: Metformin alone or with insulin has lower readmission rates (20-26%). It's a go-to drug that seems to help without extra risks.**

- **Overall trend: Single meds like insulin or metformin keep readmissions down (17-22% rate). But adding certain other drugs (like sulfonylureas) bumps it up to 25-35%, possibly due to side effects or poor control.**

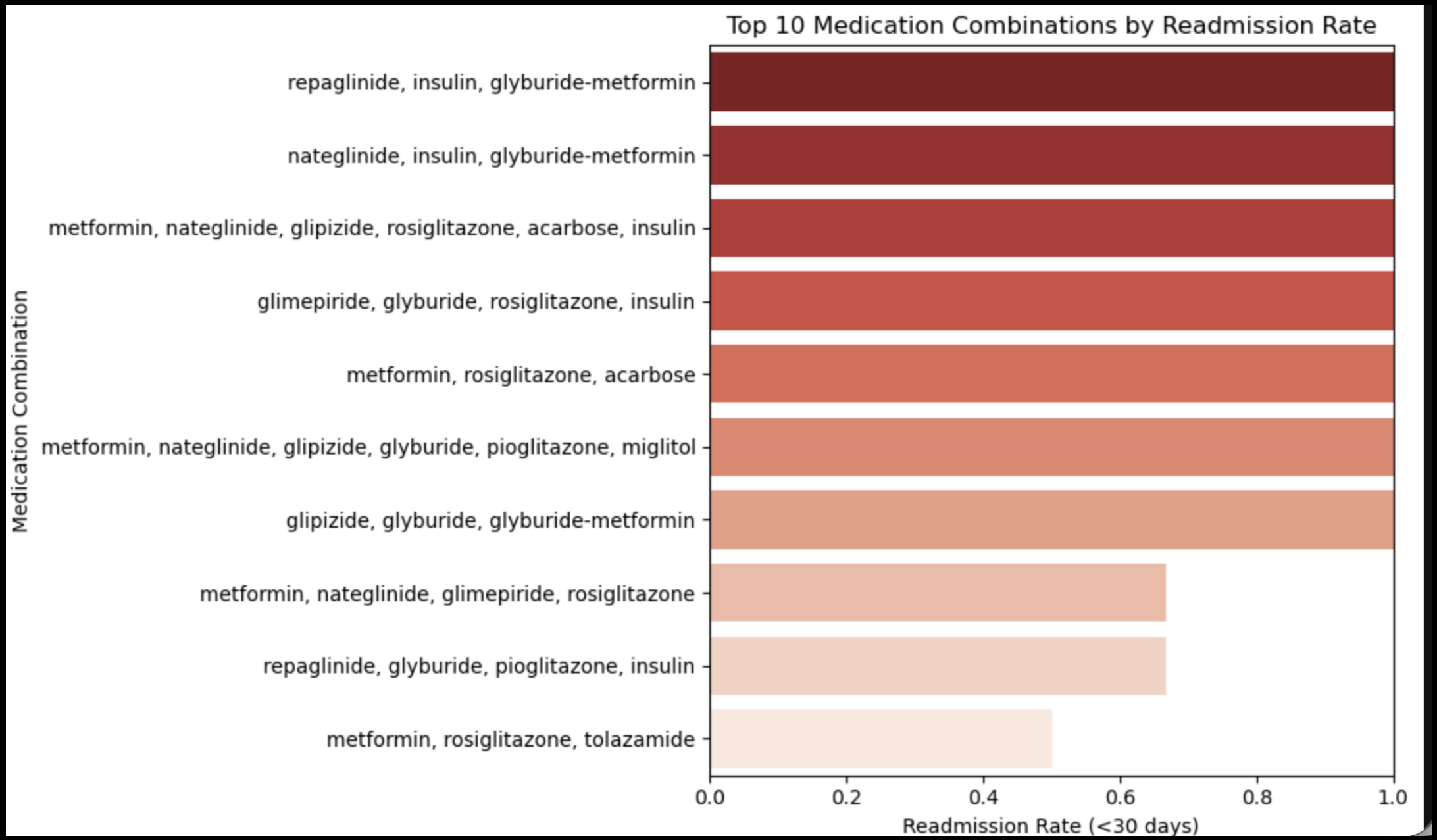
Implications

- **Switch to Safer Meds**: Encourage using metformin alone or with insulin instead of riskier combos like glipizide or glyburide, which can lead to low blood sugar and readmissions.

- **Teach Patients About Risks**: Show patients how to spot low blood sugar signs (e.g., shakiness, sweating) and what to do, helping them avoid emergency visits.

- **Check Meds Regularly**: Review and adjust medication plans often, especially for patients on multiple drugs, to keep diabetes under control and reduce readmission chances.

- **Add Education Support**: Offer simple diabetes management classes or follow-ups to help patients stick to their treatment and lower the risk of returning to the hospital.


Top 10 Medication Combinations by Readmission Rate
repaglinide, insulin, glyburide-metformin
nateglinide, insulin, glyburide-metformin
metformin, nateglinide, glipizide, rosiglitazone, acarbose, insulin
glimepiride, glyburide, rosiglitazone, insulin
metformin, rosiglitazone, acarbose
metformin, nateglinide, glipizide, glyburide, pioglitazone, miglitol
glipizide, glyburide, glyburide-metformin
metformin, nateglinide, glimepiride, rosiglitazone
repaglinide, glyburide, pioglitazone, insulin
metformin, rosiglitazone, tolazamide
Medication Combination
0.0
0.2
0.4
0.6
0.8
1.0
Readmission Rate (<30 days)

Simple Findings from the Graph

- Highest Readmission Risk: Combos with repaglinide, insulin, and glyburide-metformin top the list with a readmission rate near 1.0 (100%), meaning almost all patients on this mix return within 30 days.

- Complex Combos Are Risky: Multi-drug combos (e.g., metformin with nateglinide, glipizide, rosiglitazone, acarbose, and insulin) show high rates (around 0.8-0.9), suggesting too many meds increase readmission chances.

- Sulfonylureas Add Risk: Drugs like glimepiride, glyburide, and glipizide in combos (e.g., with rosiglitazone and insulin) have rates around 0.7-0.9, pointing to higher risks, possibly from low blood sugar.

- Some Combos Are Lower Risk: Simpler mixes like metformin, rosiglitazone, and tolazamide have a rate around 0.4-0.5, showing they're less likely to lead to readmissions.

Implications for Doctors

- Simplify Treatment Plans: Avoid overloading patients with multiple drugs; try sticking to 1-2 meds like metformin or rosiglitazone to lower readmission risks.

- Watch Sulfonylurea Use: Be cautious with glipizide, glyburide, or glimepiride, especially with insulin, and monitor for low blood sugar to prevent emergencies.

- Educate Patients: Teach patients on high-risk combos (like repaglinide mixes) how to manage side effects and when to seek help, reducing return visits.

- Regular Check-Ups: Schedule frequent follow-ups for patients on complex regimens to adjust meds and keep diabetes under control, aiming to cut readmissions.

RECOMMENDATIONS TO REDUCE READMISSIONS

- Ensure consistent testing: Require A1C and glucose serum tests for all diabetic patients.
- Specialty alignment: Prioritize endocrinologist referrals for complex diabetic cases instead of general practitioners.
- Improve documentation: Reduce “Unknown” medical specialty assignments through stricter data entry standards.
- Medication monitoring: Closely monitor high-risk drug combinations that drive readmissions.
- Data-driven practice: Use dashboards for continuous monitoring of readmission drivers.

CONCLUSION

- Findings: Readmissions were strongly linked to high A1C/glucose levels, polypharmacy, length of stay, and certain specialties (endocrinology, internal medicine).
- Hypotheses: validated that patients with poor diabetes control and complex treatments are at significantly higher risk of readmission.
- Objectives Met: Cleaned data (PostgreSQL/Python), explored trends, built ML models (Logistic, RF, XGBoost), and visualized results in Tableau.
- Recommendations: prioritize medication reviews, closer monitoring of high A1C patients, improved discharge planning, and specialty-specific interventions.
- Takeaway: Readmissions can be predicted and reduced with data-driven insights, leading to better outcomes and lower costs.

DISCUSSION

- Analysis show that readmissions are strongly influenced by medication complexity, poor glucose control, and specialty treatment patterns.
- These results reinforce prior research on diabetes management while uncovering distinct risks in specialty assignments and treatment practices.
- Limitations include reliance on historical ICD-9 data, potential coding inconsistencies, and the absence of behavioral or social health factors.
- Despite these constraints, the study provides a robust evidence base for predictive modeling and targeted hospital interventions.